Unraveling the magnetic domain structure of nanopatterned hard/soft bilayer antidot arrays with long-range periodicity

Andreas Kaidatzis[1], Rafael P. del Real[2], Raquel Alvaro[3],
Dimitrios Niarchos [1], Manuel Vázquez[2], José Miguel García-Martín[3]

[1] Institute of Nanoscience and Nanotechnology-NCSR Demokritos, Athens, Greece
[2] ICMM-Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Cantoblanco, Madrid, Spain
[3] Instituto de Micro y Nanotecnología, IMN-CNM, CSIC (CEI UAM+CSIC), Tres Cantos, Spain
josemiguel.garcia.martin@csic.es

Magnetic antidot arrays are groups of ordered holes patterned on a continuous magnetic film, which are being studied for several applications such as magnetically-active plasmonic media, microwave devices, and magnetic sensors, to name a few. In this work [1], a top-down approach with focused ion beam has been used to fabricate Co/Permalloy hard/soft bilayer magnetic antidot arrays with square and hexagonal symmetries (antidot diameter: 40 nm; lattice constant: 240 or 360 nm). The long-range periodicity of these arrays results in higher magnetic coercivity and stronger magnetic domain-wall pinning, compared to identical hard/soft bilayers of short-range order antidots deposited on porous alumina [2]. Finally, Magnetic Force Microscopy imaging shows striking qualitative differences between the two symmetries: hexagonal arrays show a homogeneous magnetic configuration, whereas square ones have super-domains (regions with uniform magnetization texture) separated by super domain-walls (SDWs), see Figure 1. Two kinds of SDWs are observed: low stray field energy (LE-SDWs) that are linear and expand over several lattice constants, and high stray field energy (HE-SDWs) that occupy only a few lattice constants and are situated at kinks of LE-SDWs.

References

[1] A. Kaidatzis, R. P. del Real, R. Alvaro, D. Niarchos, M. Vázquez, and J. M. García-Martín, Nanopatterned hard/soft bilayer magnetic antidot arrays with long-range periodicity, J. Magn. Magn. Mater. **498** 166142 (2020)
[2] F. Béron, A. Kaidatzis, M. F. Velo, L. C. C. Arzuza, E. M. Palmero, R. P. del Real, D. Niarchos, K. P. Pirota, and J. M. García-Martín, Nanometer scale hard/soft bilayer magnetic antidots, Nanoscale Res. Lett. **11** 86 (2016)

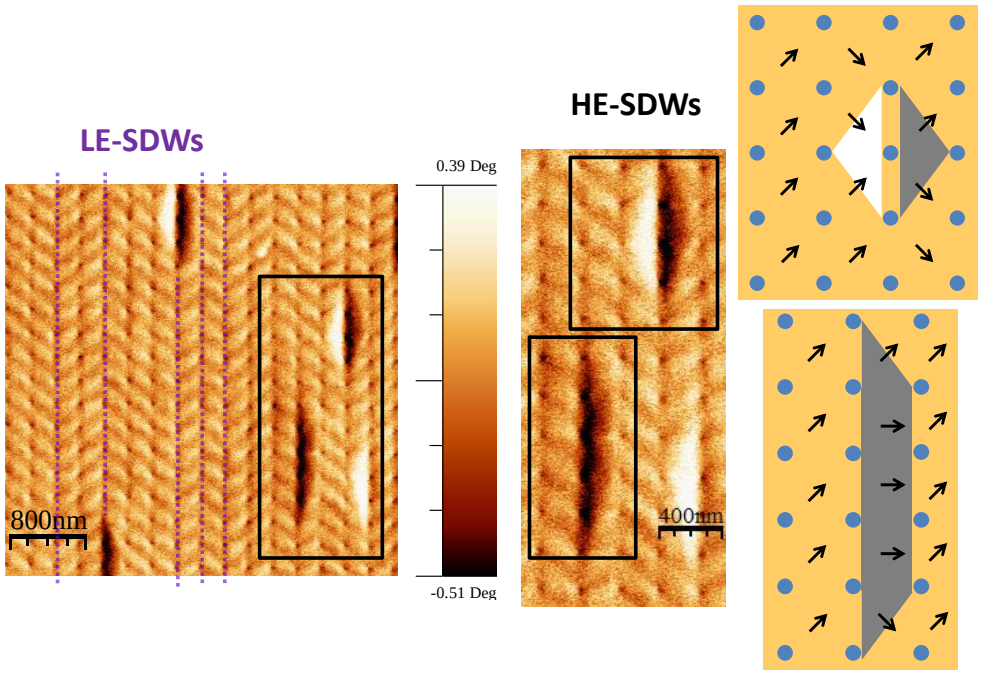

Figure 1. Representative MFM image and interpretation of a Co/Permalloy antidot array with square symmetry.